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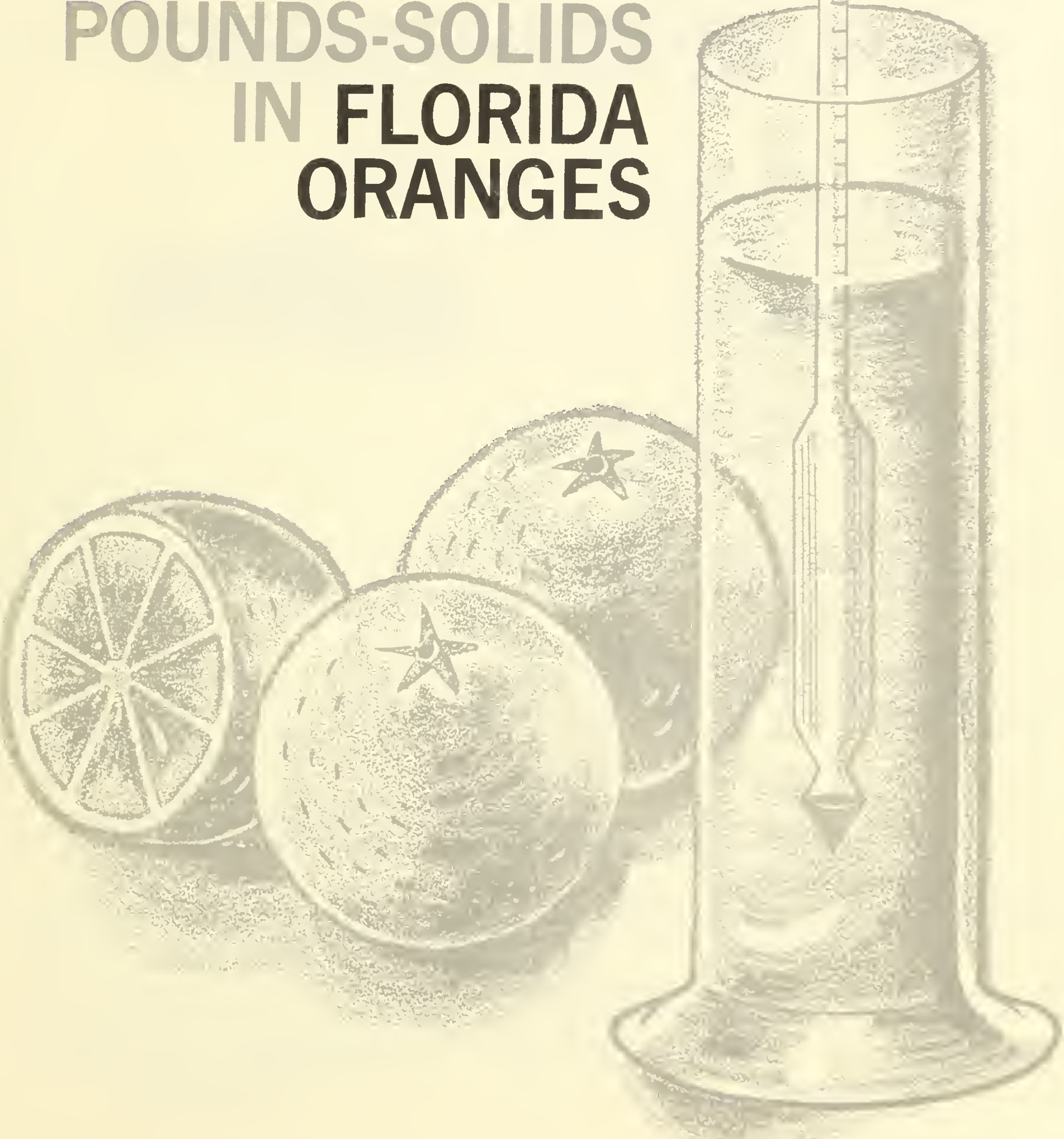
FORECASTING QUALITY AND POUNDS-SOLIDS IN FLORIDA ORANGES



AMS-533

U.S. Department of Agriculture - Agricultural Marketing Service - Market Quality Research Division

PREFACE

A study of the seasonal changes in Florida oranges was undertaken primarily to ascertain the changes that occur in different varieties of oranges (Citrus sinensis (L.) Osbeck) as they mature and ripen on the tree, and the influence of various factors known to affect the eating quality and food value of the fruit. Some of these data are presented for the purpose of forecasting quality in oranges.

This research is a part of a broad program to measure and improve the quality of agricultural products as they move in marketing channels.

Washington, D.C. May 1964

FORECASTING QUALITY AND POUNDS-SOLIDS IN FLORIDA ORANGES

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SUMMARY

Reasonably accurate evaluation and forecasting of Florida orange quality each crop year should be possible by comparing the composition of the fruit early in the season with the average data for early-, mid-, and late-season oranges as contained in this report. Representatives of the orange industry requested that previously published data be presented in varietal average form.

A major portion of the Florida orange crop is processed as concentrate, and most oranges for processing are bought on a pounds-solids basis. (Pounds-solids is total solids times volume of juice.)

Basic data are presented for forecasting the quality of oranges by reference to average figures for total solids, total acid, volume of juice, and pounds-solids taken at intervals during a number of years for early-, mid-, and late-season oranges. Each average is based on individual fruit analyses. The total number tested was somewhat more than 10,000 fruits.

The findings show that total solids, volume of juice, and pounds-solids increase with the development and maturation of the fruit. The total acid content decreases. Late-season oranges contain greater amounts of total solids and pounds-solids per weight unit of fruit than the early- or midseason oranges.

Size of fruit influences internal quality; and during the period from September to January, the average pounds-solids in early-season oranges increase from an average of 4.01 to 4.93 per 90 pounds of fruit, and midseason oranges from an average of 3.75 to 5.04. During the sampling period from December to May, late-season oranges increase from 4.52 to 5.75.

The greatest difference in pounds-solids between the very small and the very large fruit was 1.71 for Hamlin oranges, 1.34 for Pineapple oranges, and 2.70 for Valencias. The greater pounds-solids found were in the smaller-sized oranges.

Many factors affect appearance and the internal composition and yield of citrus fruits. Among these are variety or kind, rootstocks on which the trees are grown, maturity and ripeness of the fruit, age and amount of fruit on the trees, sunshine, soil moisture, soil type, fertilizers, cultivation, and spray materials.

A technical bulletin on the seasonal changes in Florida oranges has been published by the U.S. Department of Agriculture[1]. This covers studies made during the period 1935 to

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[1] Harding, Paul L., Winston, J. R., and Fisher, D. F. Seasonal Changes in Florida Oranges. U. S. Dept. Agr. Tech. Bul. No. 753, 88p. illus, 1940 (Reissued 1961.)

1938. The publication gives in some detail the physical characteristics and chemical composition of the principal varieties of Florida oranges along with the rootstocks on which different varieties were grown, the location of the test plots and the cultural conditions. Data are presented for each fruit sampling and for each variety. Part of the data used in this AMS report is presented in tabular form in the above technical bulletin, tables 10 through 29 (appendix). Other information pertinent to orange quality is published elsewhere[2].

INTRODUCTION

In the past, citrus crop estimates have been made on a volume or box-production basis. However, recently there is increasing interest and some experimental effort toward forecasting average fruit quality in terms of pounds-solids per box (90 pounds) of fruit, in addition to the usual total-box citrus crop. This additional information is potentially useful because of the large volume of fruit now processed as citrus concentrate, where a high total solids content and a high juice volume are of utmost importance. Most oranges for processing are bought on a pounds-solids basis.

A reliable prediction of internal quality would be beneficial for other citrus producing areas. Where data on average trends are available, basic data pointing to forecasting quality in citrus fruits could readily be employed.

Fruit quality and taste appeal are directly related to the texture of the flesh, juiciness, contents of total solids and total acid, the ratio of total solids to total acid, and a host of trace components which go to make up "flavor." The flavor of orange juice is sour or very tart when the total acid content is high; on the other hand, the flavor is insipid and flat when the acidity is exceptionally low. A high sugar content with sufficient total acid to produce a balanced flavor brings it to prime quality.

MATERIAL AND METHODS

The test plots were located in commercial citrus groves, and the fruit was from trees grown on different rootstocks, namely: Rough lemon (Citrus limonia Osbeck); sour orange (C. aurentium L.); grapefruit (C. grandis (L.) Osbeck); sweet orange (C. sinensis (L.) Osbeck); and Cleopatra, or spice mandarin (C. nobilis Lour. var. deliciosa (Tenore) Swingle). Oranges for the tests were taken at random during a number of years, care being taken to pick only exposed fruit of the regular bloom. The samples were usually collected at intervals of 2 weeks until commercial picking of the plots. After this, only a few trees were reserved to supply fruit for the later analyses which were made at somewhat longer intervals, depending on the amount of fruit reserved. Each variety was sampled over a period of several months so that fruit of the various stages of maturity were included. The results are average values obtained from individual fruit measurements and individual fruit analyses, ranging from 325 to 2,225 fruits for each season of fruit classification. Included in the average values are within-sample fruit variations, fruit from different picking periods, different groves, rootstocks, varieties, and crop years. Thus each average value is based on a wide cross section of fruit.

For graphic presentation, the data were grouped within the following arbitrary periods: September to January (early-season varieties including Hamlin, Parson Brown, Conner, etc., and midseason varieties including Pineapple, Homosassa, Seedling, and Jaffa) and December to May (late-season varieties including Valencias and Lue Gim Gong).

The size of the fruit was determined by measurements of the diameter of the cut halves. Juice was extracted by a pressure extractor, and the volume of juice was ascertained after removal of the pulp and seeds.

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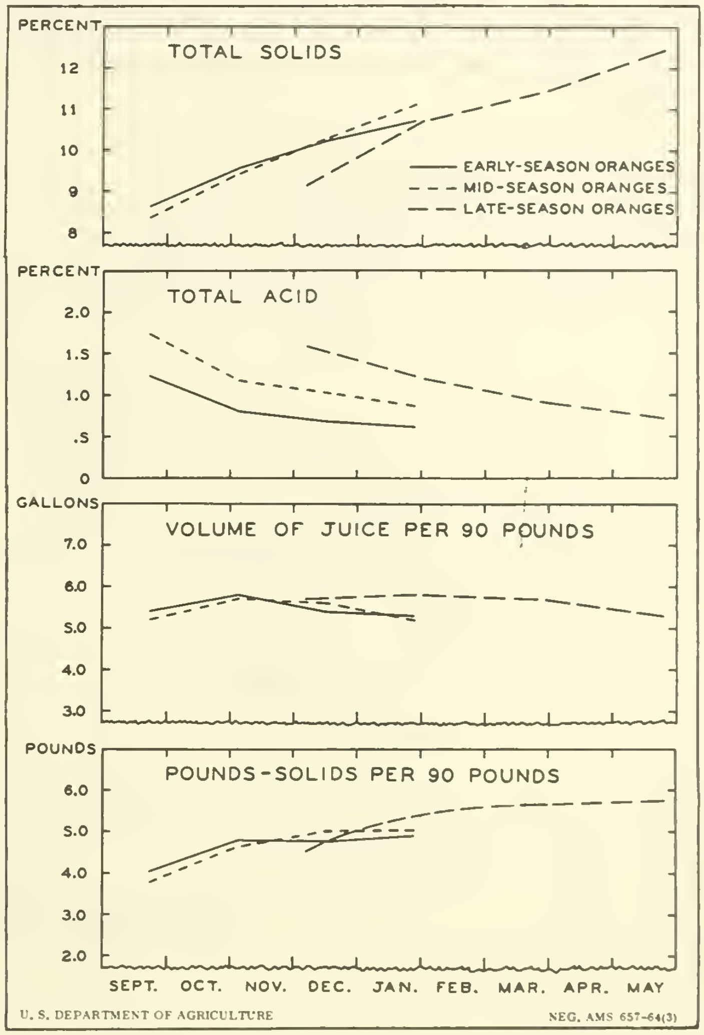
[2] Harding, Paul L., and Lewis, W. E. Relation of Size of Fruit to Solids, Acid, and Volume of Juice in the Principal Varieties of Florida Oranges. Fla. State Hort. Soc. Proc. 54:52-56. 1941.

The total soluble solids were determined by an Abbé refractometer. These percentages were considered as "Brix of the juice" in calculating pounds-solids per gallon[3]. The pounds-solids per gallon times the gallons of juice per 90 pounds of fruit gave the total pounds of solids. Total acid was determined by titration of the juice with standard NaOH, using phenolthalein as an indicator.

RESULTS

Total Solids.--An increase in the percentage of total solids with the development and maturation of fruit is shown in figure 1. The average total solids content for the early-season oranges was in close agreement with that of midseason oranges. Late-maturing oranges (Valencia and Lue Gim Gong) developed greater total solids content than the early- or midseason fruit. During the period from September to January, average total solids values increased in early-season oranges from 8.6 to 10.7 percent. In the midseason fruit, the increase was from 8.4 to 11.7 percent. Total solids of late-season oranges increased from 9.2 to 12.5 percent from December to May.


TOTAL SOLIDS

TOTAL ACID

VOLUME OF JUICE PER 90 POUNDS

POUNDS-SOLIDS PER 90 POUNDS

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Figure 1.--Interrelation of total solids, total acid, volume of juice, and pounds-solids in early-, mid-, and late-season oranges (averages of all data).

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[3] Soule, M. J., Jr., and Lawrence, F. P. What Every Citrus Grower Should Know--Maturity Tests for Fresh Fruit. Univ. of Fla. Circ. 191, 18 pp. 1959.

Years of high fruit quality would be indicated when total solids, total acid, volume of juice, and pounds-solids on a given date ranged above the average trends as shown in figure 1. On the other hand, only average quality would be anticipated when the above items equaled or were slightly below the averages.

The size of the fruit affected the percentage of total solids in the juice (fig. 2). During September and October, comparatively slight differences in total solids content were shown between the smaller- and larger-sized Hamlin oranges. Later in the season the divergence usually became greater, and the juice of smaller-sized oranges contained a higher percentage of total solids than the larger ones. Size had no consistent effect on total solids of Pineapple oranges except that size 126 had consistently lower solids than smaller fruit. In Valencia oranges, the differences in total solids due to size of fruit (216's, 200's, 176's, 150's, 126's, and 96's) were very consistent throughout the sampling period, the smaller fruit having the highest percent total solids in the juice.

Total Acid.--Juice of early varieties of oranges contained smaller concentrations of acid than juice of midseason ones (fig. 1). Also, during the period from September to January, the total acid decreased in early oranges from an average of 1.23 to 0.63 percent, and that in midseason oranges decreased from an average of 1.73 to 0.86 percent. During the December to May period, total acid decreased from an average of 1.59 to 0.71 percent in the late oranges.

The data on the effect of size of fruit on total acid content are discussed in another publication (see footnote 2). The findings indicate differences in acidity between different size fruits, the smaller fruits usually having the higher acid content. Other results showed that the total acid content was influenced by variety, age of trees, rootstocks, and crop years.

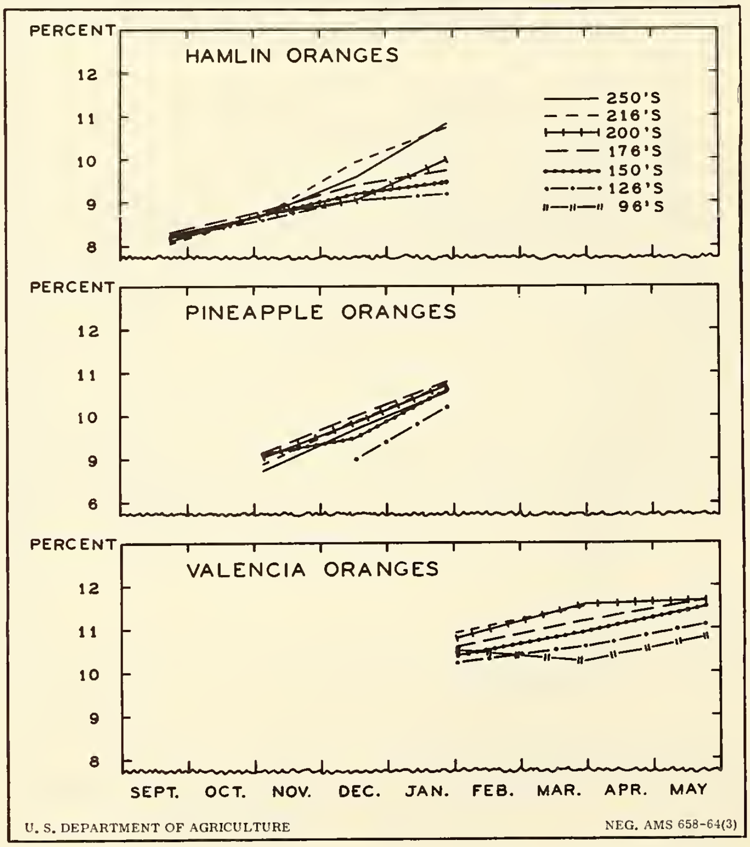

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Figure 2.--Relation of fruit size to total solids content in different varieties of oranges grown on rough lemon rootstock.

Juice Volume.--The greatest volume of juice, ranging from about 5.7 to 5.8 gallons per 90 pounds of fruit, occurred during prime condition of the oranges. The data in figure 1 show that there was a tendency for the juice volume to increase slightly with fruit ripening and to decrease slightly with overripeness. This trend in juice volume was more pronounced in early- and midseason than in late-season oranges. The average juice volume in late-season oranges was almost uniform, with a slight decrease in volume late in the season when granulation occurred.

Fruit size influenced the amount of juice obtained. Harding and Lewis (see footnotes 1 and 2) have pointed out that when the volume of juice was calculated as gallons per 90 pounds of fruit, the smaller-size oranges (250's, 216's, 200's, 176's, and 150's) contained more juice than the larger ones (96's and 126's).

Pounds-Solids.--The amount of pounds-solids in citrus fruits is based on the concentration of total solids and the juice volume. Pounds-solids usually increased with fruit ripening. During the period from September to January, early-season oranges increased from an average of 4.01 to 4.93 pounds-solids per 90 pounds of fruit, and the midseason oranges from an average of 3.75 to 5.04 pounds-solids. Late-season oranges contained greater amounts of pounds-solids than the early- and midseason kinds. During the sampling period from December to May, the average pounds-solids increased from 4.52 to 5.75. Pounds-solids was consistently uniform during the period of prime eating condition of the fruit (fig. 1).

Size of oranges did affect the amount of pounds-solids per 90 pounds of fruit. The differences (fig. 3) were more pronounced in the late samplings of fruit than in the early ones, and the results showed more pounds of solids per weight unit in the smaller Hamlin, Pineapple, and Valencias than in the larger-size oranges. In the Hamlin oranges, the greatest overall difference in pounds-solids due to size was 1.71; in Pineapples it was 1.34, and in Valencias 2.70.

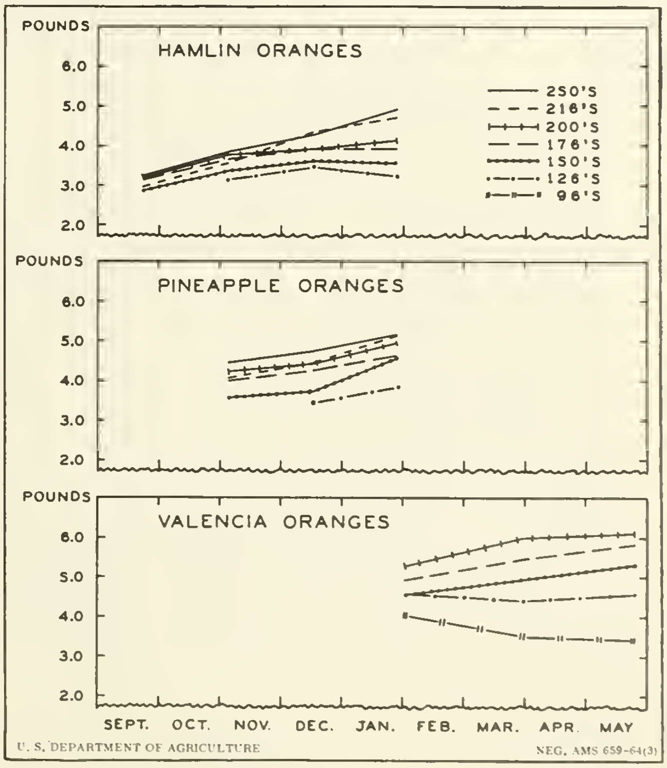

Figure 3.--Effect of fruit size on pounds-solids in different varieties of oranges grown on rough lemon rootstock.

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